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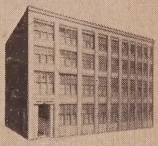

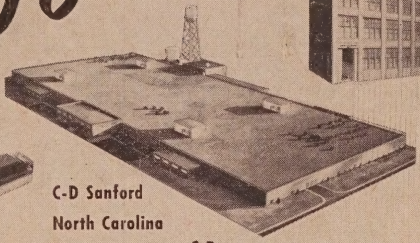

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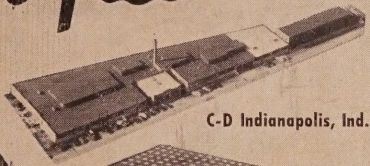

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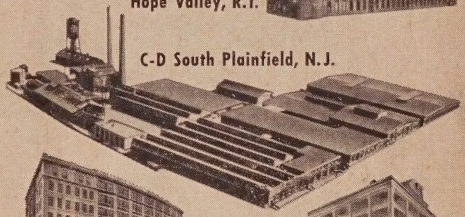

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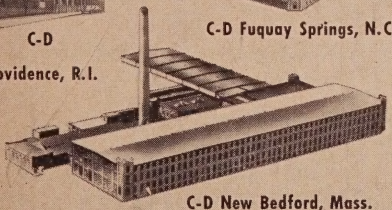

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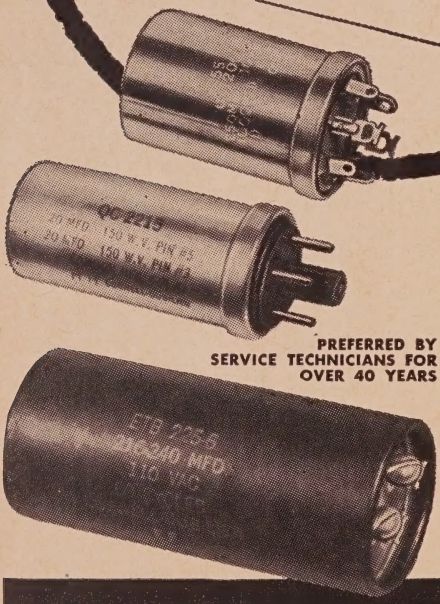

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NOISE TESTS AND MEASURMENTS

The fact that amplifiers and receivers, both radio and TV, can be sources of "noise," is well known. In amplifiers and radios, noise offends the ear as a hiss, rushing sound, or (in extreme cases) roar. In the video section of a TV set, the eye is bothered by snow and similar disturbances on the screen. Any experienced technician has at some time given thought to noise reduction. But few have bothered to inquire into the nature of internal noise or appreciate the importance of noise measurements. The purpose of this article is to shed some practical light on the general subject of noise and noise tests in electronic systems.

The material presented here is not original by any means. It is basic and has been digested from many authoritative sources. But it probably will be brand new to numerous technicians in need of a practical presentation.

Significance of Noise Level

Aside from its obvious disturbing features, noise level is extremely important in the design and improvement of high-gain electronic systems. The unavoidable presence of noise in a sensitive system, such as an amplifier or receiver, for example, puts a practical limit on the weakest signal that can be handled. Signals having amplitudes less than that of the noise generated within the system are masked by the noise, while those of the same amplitude must compete unfavorably. Thus, the amount of internal noise limits the usable sensitivity of a receiver or the usable voltage gain of an amplifier.

Likewise, the amount of **usable** gain that may be obtained with a preselector, converter, preamplifier, or TV booster depends upon the inherent noise level of that accessory. Although providing considerable voltage gain, a device of this sort offers no over-all improvement in the performance of the system ahead of which it is operated if it adds to, or keeps constant (in some cases) the amount of noise with respect to the amount of signal in the system.

For determining the relationship between noise and signal, and also to express the improvement to be expected from boosters and preamplifiers, our yardstick is the ratio of signal amplitude to noise amplitude. This is called the **signal-to-noise** ratio.

If the output signal measured at the loudspeaker terminals of an amplifier is 4 volts, and the voltage due to noise alone in the absence of the signal is 4 millivolts, the signal-to-noise ratio is $4/0.004 = 1000$ to 1. Also: If the signal voltage at a TV picture tube is measured as 9000 microvolts and the noise voltage at the same point 850 microvolts, the signal-to-noise ratio is 10.6 to 1.

The amount of noise in a system is expressed as its **Noise Figure** in so many db. This may be considered as the db ratio between the signal-to-noise ratio of an ideal, perfect system and the signal-to-noise ratio of the practical system under inspection.

Nature of Noise

Electrical noise has the characteristic of being unpitched (non-periodic). In audio systems, it is usually harsh to the ear. This feature distinguishes noise from other types of interference, such as hum, oscillation, and spurious modulation. Noise voltage is spurious and is considered to be composed of large numbers of narrow pulses of different amplitudes which occur at random frequencies. **Impulsive** noise (characterized by ignition interference) consists of separately recognizable sharp pulses, while **random** noise (an example of which

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is tube hiss) is composed of rapidly successive pulses which often overlap.

Electrical noise arises from several sources and is typed according to these origins. The principal types are discussed in the following paragraphs.

(1) External Origin. This includes all noise impulses which arise outside of the electronic system. Examples are static (natural and man-made), cosmic hiss, etc. Such impulses are picked up by receiving antennas or the unshielded input circuits of receivers and amplifiers. Generally, very little control of these noises is possible, with respect to the signal amplitude, once they enter the electronic system. Their elimination is achieved efficiently only at the points of their origin. Man has no control, of course, over natural and cosmic sources. In receivers, antenna noise usually is low, compared to noises arising from other sources.

(2) Tube Noise Voltages. The principal noise voltage generated by an electron tube is caused by random variations in current. Called **"shot effect,"** these variations are due to the fact that emission from the cathode consists of electrons, which are discrete particles. The current thus is not a continuous flow of fluid. Tube noise voltages are caused also by random variations in grid current (due to the presence of positive ions resulting from gas traces) and random variation in current division between the plate and other positively-charged electrodes.

Noise output often is a problem with converter tubes especially. A pentode tube generates approximately 3 times as much noise energy as a triode with the same amplification.

In practical electronic circuits, the lowest input-signal voltage which can be amplified often is limited more by tube noise than by noise arising from other sources.

(3) Thermal Agitation. This noise source is the random motion of free electrons in a conductor. It is called **thermal** agitation because the random movement is associated with the heat energy in the conductor material. Another name is **Johnson** noise. When the interval of observation is made quite small, the thermal motion of free electrons in a conductor is seen to be non-uniform. The resulting variations are the cause of the so-called thermal noise.

In the theoretically perfect receiver mentioned earlier in this article, any noise is assumed to be due only to thermal agitation (generated in an imaginary resistance equal to the antenna radiation resistance), no other sources supposedly existing in this perfect system.

The noise voltage produced across the terminals of a conductor by thermal agitation is the theoretical minimum (although not attainable in practice), and is proportional to kTB. Here: T is the absolute temperature in degrees Kelvin ($°K = °C + 273.16$), B is the bandwidth ($f_2 - f_1$) of the range in which noise is measured, and k is Boltzmann's Constant (1.374×10^{-23} joule per °K).

This says that the Noise Figure is directly proportional to temperature and to bandwidth. It is proportional also to the resistive component of the impedance across which the noise voltage is developed, but R often is constant in a given system. Expect your electronic system to be noisier when heated; and if it is a wide-band device, it will be noisier than a sharply-tuned system. The latter is obvious, since a wide-band system allows more of the random noise frequencies to pass through. Don't

expect a wide-band, untuned TV booster to give as snow-free a signal as a sharply-tuned, or single-channel booster. As an analogy consider that the successful reproduction of **audible** noise requires efficient transmission throughout the a-f spectrum. For this reason, certain noises such as hand-clapping, key-jingling, etc., often are used for quick, qualitative testing of a high-fidelity audio system.

The noise level due to thermal agitation is expressed by the following equation:

$$(1) \quad E^2 = 4kT \int_{f_1}^{f_2} R \, df$$

Where E^2 is the square of effective value of voltage between frequencies f_1 and f_2, k is Boltzmann's Constant as given earlier, T the temperature (°K), R the resistive component of the impedance across which the thermal agitation voltage is developed (function of frequency), and df is is the bandwidth $(f_2 - f_1)$.

Lest our less-mathematical readers are floored by the foregoing important equation, we hasten to explain that this equation says only that if R is plotted against frequency, a peaked curve is obtained; and if we compute the area under that curve between the pass-band limits (f_1 and f_2) and then multiply this area by 4kT, the result is the square of the voltage. When resistance R is independent of frequency, Equation (1) is reduced to the simpler form:

$$(2) \quad E = \sqrt{kTR\,(f_2 - f_1)}$$

Thermal agitation in the input tuned circuit of a receiver often is important in determining the noise level of a refined system and the smallest usable input-signal amplitude. The energy resulting from thermal agitation voltages across a resistance, R, is distributed throughout the frequency spectrum from zero to many megacycles. It is interesting to note that it is the actual bandwidth $(f_2 - f_1)$ and not the position of this band within the spectrum that determines the thermal agitation voltage level.

Since the expression kTB represents the theoretical minimum Noise Figure, all practical Noise Figures are referred to it as a certain number of db above kTB. It is this noise rating, db above kTB, that determines the usable voltage gain of a system.

(4) **Resistor Noise.** Noise voltages, proportional to current flow, are generated in carbon resistors as a result of fluctuation in contact resistance between adjacent carbon granules. For this reason, carbon resistors are not used in the critical positions in the input stages of sensitive electronic systems.

Summarizing, we see that noise is inherent in electronic systems and that its nature is random voltage pulses distributed throughout the frequency spectrum and arising from various sources. Unless defective circuit components are present, these sources are (1) tube effects, (2) thermal agitation, and (3) carbon resistors. In practice, "shot effect" in tubes often is stronger than thermal agitation in limiting the weakest usable signal that may be amplified by the system.

Practical Considerations

The discussion up to this point has defined noise, and described the phenomena responsible for its generation and the factors upon which it is dependent. Our concern now is to see how this fits into the practical consideration of electronic systems and how to use it as a tool. In the following discussion, several illustra-

tive examples will be given. Each of these will be purely hypothetical, although entirely logical. The figures do not apply to any particular existing amplifier or receiver and are not intended to display in a bad light any such device presently in use.

Example 1. An amplifier has a voltage gain of 100. At its output terminals (high-impedance loaded), a 0.2-volt signal is measured. The noise output voltage is 2 millivolts (0.002 v). This is a signal-to-noise ratio of 100:1.

It is desired to increase the gain of the system to 1000 by means of a preamplifier having a voltage gain of 10. The available preamplifier has a signal-to-noise ratio of 50 which is twice as bad as that of the main amplifier. Thus, the signal is amplified 100 times, and the main amplifier output becomes 20 volts. But twice the noise voltage also is amplified 100 times and this becomes 0.4 v. Now, the signal-to-noise ratio is 50:1. Although we have succeeded in increasing the gain, we also have more noise to contend with.

If the preamplifier had the same signal-to-noise ratio as the main amplifier, the required boost of 10X would be obtained at no increase in noise.

Example 2. Signal-to-noise ratios of 100 to 1 or better are desirable in TV receivers to insure snow-free pictures. A certain TV receiver is operated in a fringe area, so a booster is required. With this set operating below its agc threshold, a signal of 1,000,000 microvolts is measured at the picture tube. The noise voltage at the same point is 100,000 microvolts. Here, we have a signal-to-noise ratio of 10:1, or 20 db.

One booster available for the purpose has a gain of 10X and has the same Noise Figure, 20 db. This combination of booster and receiver gives a picture-tube signal voltage of 10,000,000 and a noise voltage of 1,000,000. The signal-to-noise ratio remains 10:1, so greater sensitivity has been obtained without increasing the noise level. But neither is the noise ratio improved. The result is increased gain but no improvement in the picture.

Example 3. A second booster available also will provide a voltage gain of 10X, but its Noise Figure is 26 db. This additional 6 db over the Noise Figure of the receiver means that twice as much noise voltage is generated. Therefore, this booster would increase the signal to 10,000,000 microvolts, as the first one would, but the noise is increased to 2,000,000 microvolts. Now, the desired gain has been obtained with a worse signal-to-noise ratio: 5:1, certainly conducive to snow.

Example 4. A third booster has 10X gain with a signal-to-noise ratio of 40 db. This change of 20 db in the Noise Figure means that only half as much noise is generated by the third booster, as by the receiver. This lower noise level is amplified in the set along with the signal, so that now the output signal voltage is 10,000,000 microvolts as required, at an improved noise level. The result: improved sensitivity with improved picture quality.

Noise Tests

It is not easy to measure the signal-to-noise ratio of a receiver by ordinary methods. It is difficult to observe and measure the random voltage, except with an oscilloscope, and even then care is required in making the measurements and evaluating the data.

When the noise is of a relatively continuous nature, a keyed or warbled

signal from a microvolt-calibrated r-f signal generator may be employed. The generator is connected to the receiver by appropriate impedance-matching networks. The signal amplitude is adjusted to a level just barely audible in the presence of the background noise. This level in microvolts, read from the generator output controls, then can be assumed to correspond approximately to the receiver noise level. It may be compared with kTB to determine the Noise Figure, or with the signal output voltage (with all controls in the same positions as before) to determine signal-to-noise ratio.

Another method is to connect a high-quality equivalent dummy antenna to the receiver input terminals and to measure the residual noise voltage at the receiver output.

The noise level of an audio amplifier may be determined in a similar manner. Residual noise voltage may be measured at the properly-terminated output of the amplifier, and this emf compared with signal-output voltage, with all amplifier controls in the same positions as before.

In each of these methods, more than ordinary care must be taken that hum or stray signal voltages are not included in the noise measurement.

Noise Diode. Special diode tube noise generators are invaluable for the comparatively simple determination of Noise Figure of amplifiers and receivers.

In the tube, "shot-noise" energy due to a-c components of the fluctuating diode plate current is proportional to the average d-c current. For a given current, the noise is maximum when the plate collects all of the electrons emitted by the filament. When this condition obtains, the emission is said to be temperature-limited. In a frequency band $f_2 - f_1$, the rms current in a temperature-limited diode tube is:

$$(3) \quad i = \sqrt{3.18 \times 10^{-19} \, I \, \Delta f}$$

Where i is the rms fluctuating current (amp), I the diode d-c plate current (amp), and Δf the frequency band in which noise is measured.

The temperature-limited diode may be used to check the noise characteristics of amplifiers and receivers. When operated with sufficient plate voltage to saturate the emission, the random r-f noise (hiss) generated by the diode is wide-band and constant. Its level can be adjusted by varying the filament voltage. The noise output is proportional to the d-c plate current which is easily read.

With the diode operated as a source of known noise power, the amplifier under test is operated first with its input terminals terminated and its noise output (P_a) observed with a relative-power meter. Then, the diode noise output power (P_n) is fed into the amplifier and increased to the point where the amplifier power output doubles. At this point $P_a = P_n$.

When the diode circuit is matched to the amplifier input, the Noise Figure can be calculated from $F = 0.02IR$, where I is the diode d-c plate current (ma) and R the amplifier input impedance (ohms). F also equals 10 log (0.02IR), in db.

This test procedure may be employed also with receivers, including TV. A typical temperature-limited diode tube designed for noise measurements is the Sylvania Type 5722.

Crystal Diode. Since temperature-limited diode tubes are rather expensive and easily damaged, as well as requiring some complication in their filament-controlling power supply, the experimenter and service technician

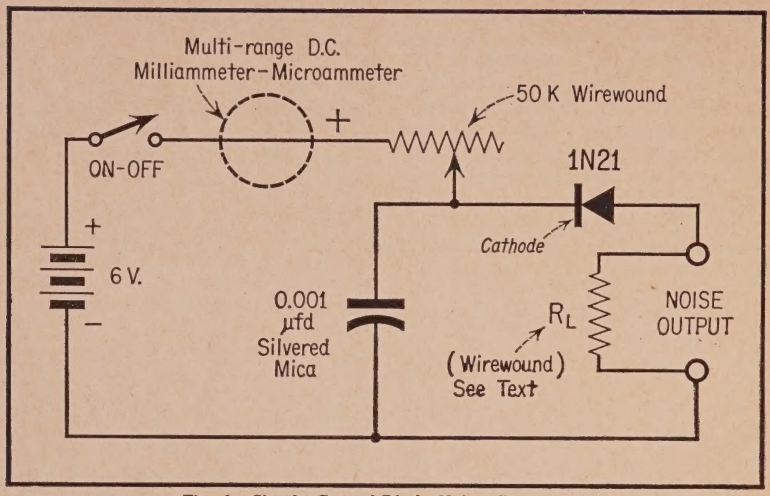

Fig. 1. Simple Crystal-Diode Noise Generator.

interested in making noise tests will prefer a less critical device. For this purpose, a noise generator using a crystal diode is recommended.

Such a circuit was described in the December, 1953, issue of the C-D CAPACITOR and is reproduced here in Figure 1. A silicon crystal, such as surplus 1N21 series, is employed — unfortunately, the popular germanium diodes are unsatisfactory for this purpose. The circuit generates useful noise up to several thousand megacycles.

The 50,000-ohm rheostat is the noise output control. The d-c current meter will be of aid in setting to exact values of diode reverse current. It can be omitted for reasons of economy, however, and settings of the rheostat used for the same indications.

This noise circuit is connected to the antenna terminals of the receiver, or input terminals of the amplifier under test. When the set does not provide a d-c return path, a resistance R_L equal to the receiver or amplifier input impedance must be connected temporarily across the noise output terminals, as shown in Figure 1.

Comparative tests may be made in the following manner: (1) Switch-off the avc and bfo of the receiver under test or the amc circuits, if any, of an amplifier. (2) Set the gain controls in the desired position. (3) Connect the noise generator to the device, as already explained. (4) Connect an output meter, preferably one reading audio power directly, to the output terminals of the receiver or amplifier and note its noise reading. (5) Switch-on the noise generator and increase its output until the output meter (receiver or amplifier) reads twice the first power reading (or if a voltmeter, 1.41 times the first voltage reading, or 3 db change). (6) The d-c meter or rheostat setting in the noise generator now indicates relative noise. Low current indicates low noise, and vice versa, as does a low setting of the 50,000-ohm rheostat.

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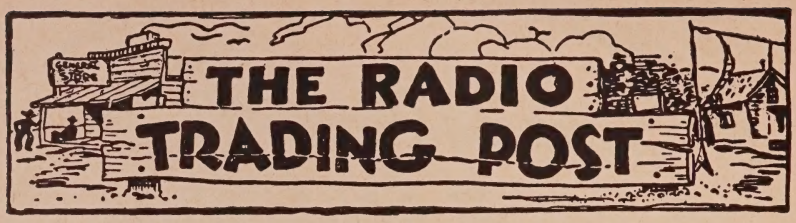

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FOR SALE — ATR model RHC inverter, 110 v. DC to 110 v. AC, 350 w. capacity, exc. cond., $25. J. P. Andrasko, 223 East 96th St., New York 28, N. Y.

WANTED — TV receiver, 630 chassis, with or without cabinet; Eico high voltage probe; TV service books. All must be reasonable and in good cond. I. J. Rohssler, 224 York St., Brooklyn 1, N. Y.

FOR SALE — GS RPX046 cartridge with .003" diamond stylus, $15; Livingston 16" transcription arm, $11; three Daven WV4-7 150/150 tee pads, l. n., $7.50 each, postpaid; Kenyon K305 xformer, $6. G. Arion, 99-05 63rd Dr., Rego Park 74, N. Y.

FOR SALE — Superior model 670-A super meter in A-1 cond., for first money order for $21. Frank Bou, 47 Oswego Ave., Audubon 6, N. J.

FOR SALE — Power supply, rack-mounting, in orig. carton, built by RCA, output 400 v., 400 MA, two-section filter with oil filled capacitors, hermatically sealed chokes and transformer, 115 v. AC, $25 FOB. R. K. Seigle, 1303 Shaw Pl., Seaford, Long Island, N. Y.

FOR SALE — Harvey-Wells TBS-50C with 500 v. power supply, new cond., and TVI'd; also Sonar LP-7 low pass filter-coax 52 ohm. All for $90. Stan Egelberg, 3630 Barnes Ave., Bronx 67, N. Y.

FOR SALE — Heathkit model V2A VTVM, $15; Heathkit model T2 sig. tracer, $15; Supreme multimeter, model 542, 5000 ohms/volt, $10. All in good working cond., cash only. George Javor, 2039 East 31st St., Lorain, Ohio.

FOR SALE — Coastwise Electronics Co., model 501-D master remote control for TV receiver, channels 2 to 13, $15. C. L. Bachofer, 939 Woodbine Ave., Rochester 19, N. Y.

SELL OR TRADE — Diversity antenna switchover adaptor 4 tubes, $6; National TMH 150 mmfd. variable transmitting condenser, unused, $3; control only, model RCR400 Tenna Rotor, $1. P. D. Boothroyd, Box 142-G, RD 1, Sparta, N. J.

WANTED — Tube tester, mutual conductance type such as EMC No. 206P or Sylvania No. 220. For Sale: Mallory Vibrapack, No. VP552, 6 v. to 225, 250, 275, 300 v. @ 100 MA, old but unused, $10 plus transportation. T. Macomber, 206 Jordan Ct., Los Altos, Calif.

FOR SALE — GE preamp, 110 v. AC, $8; ICA audio oscillator, $8. Both like new. Stanley Strangle, Trout Creek, Mich.

WANTED — Compact 10 w. audio amp., Harmon-Kardon C-100, National Horizon 10, Scott 99A, Bruciner Mark 12, or Lafayette LA5A. Unit must be in perf. operating cond. State lowest delivered price. D. Kurs, 321 Fairmount Ave., Jersey City, N. J.

FOR SALE — Super-Pro rcvr. and power supply, 100 kc. to 20 mc., $115; Dumont model 208-B 5" scope, $50; Stancor 110-C phone-CW transmitter, 100 w., $65; all FOB. M. Gersenson, 1512 Kinsdale St., Philadelphia, Pa.

SELL OR TRADE — 192 issues QST, 1924-1950; 47 issues "Radio" (no longer published) 1938-1944. Best offer, including postage, or trade for small TV set or Hi-Fi equip. Reid H. Burrows, 1320 South Appletree Lane, Milwaukee 14, Wis.

FOR SALE — Back issues, Electrical Engineering, and Proceedings IRE, 1944 thru 1950, exc. cond., make offer. J. Burke, 35 Mayfair, Rochester, N. Y.

FOR SALE — Heathkit 0-6 scope, 12AT7 vertical gain stage added; Vomax 900 VTVM. Both in good cond., $25 each. No COD. Donald Linnabary, 440 North Forest Ave., Bradley, Ill.

SELL OR SWAP — Two unused 833-A tubes, Millen R-9er with 2 sets of coils, National SW-3 receiver with 2 sets of coils. Need signal gen., R-C bridge, Gonset converter, commercial mobile ham transmitter. "Crown," Box 3042, Albuquerque, N. M.

SELL OR SWAP — BC-620 transmitter-receiver with tubes and power supply; Astatic Scanfar booster; Emerson portable, camera size; West. Elec. handsets; T17 mike. Need walkie-talkie, 30-40 mc. FM. T. West, Box 189, New London, Conn.

FOR SALE — Model 425 Eico scope, model 360 Eico sweep gen., model E200-C Precision sig. gen., model 200 Electronic tube checker, model E41A ATR battery eliminator. $125 for the lot. Glenn Grottendieck, 520 Fronheisor St., Johnstown, Pa.

TRADE — Colt 25 automatic pistol for a tube tester in good cond. Moss W. Armistead, 321 Hillsboro Ave., Edwardsville, Ill.

TRADE OR SELL — Heath 5" scope, Hickok 305A scope, unused RCA dynamic mike, Turner 22X mike, Transvision 12½" TV table model. Best offer. Nick's Radio, 116-14 120th St., Ozone Park, N. Y.

SELL OR TRADE — PE-103A; Mossberg 22 repeater; BC-454-B; car radio; SX-25. Want Valenco XTR-140; Sonar MR-3; Bassett mobile antenna; Heath grid dip meter or VTVM; Viking mobile VFO. Charlie Stiles, 816-Platte, Alliance, Neb.

SELL OR SWAP — Super-Sonic 107 TV-FM booster, $5; Zenith 5-S-127 3-band radio. Want Coyne's Applied Radio-Television or ?? Bruno DeCola, 379 So. Broadway, Salem, Ohio.

SELL OR TRADE — Weston shop portable 433 voltmeter, 600 v. 25-125 cycles for $34.50 or Weston model 730 Sensitive Alarm Relay. Have 5 volumes Radio Diagrams, Beitman, 1926 to 1942, $7. Clarence Jenior, Gen. PO Box 301, New York, N. Y.

FOR SALE — Collins 32V3 transmitter, exc. cond., $575; National NC-183 receiver with speaker, good cond., $175; PE103 dynamotor, unused, test on bench only, with spare set of brushes, $25. Don DeShazo, Jr., 529 Blackstone Ave., La-Grange, Ill.

WANTED — Sweep sig. gen., state make, model, specifications, and cond. Ted Duzak, 807 South 16th St., Newark 8, N. J.

FOR SALE — Electronic sales and service business, $3,500. Send for complete description. Charles J. Moore, Box 422, Wolfe City, Texas.

FOR SALE — Hickok model 620 cross-hatch generator; Approved Electronics model A-460 field strength meter; Triplett model 3413-A tube checker. Make offer. Want GE sig. gen. ST-4A and ST-5A, or an electronic organ. G. E. Howarth, 216 1st Ave. East, Oskaloosa, Iowa.

SELL OR TRADE — Radio News, Radio Electronics, IRE Proceedings, Electronics magazines from 1949; GI disc recorder mechanism, 11 position 24 v. AC stepper relay, RCA VTVM, and unused Cascode tuner. Arnold B. Margolis, 120-16 234th St., Cambria Heights 11, N. Y.

WANTED — Elmac PMR 6-A receiver with or without 6 or 12 v. DC supply. Sell RCA 1.14 KVA modulation transformer. Elmer E. Ash, 431 North Milwaukee St., Port Washington, Wis.

FOR SALE — ATR inverter, 110 v. DC input, 110 v. AC output at 150 w., exc. cond., sacrifice. J. P. Andrasko, 223 East 96th St., New York 28, N. Y.

SWAP — GE sig. gen., ranges 100 kc. to 150 mc. on fundamentals, l. n., and Arkay 10 w. amplifier, 3 inputs: phono, mike and preamp., for tape recorder, 35 mm. color camera or what have you. Larson's Radio Service, Madison, Minn.

WANTED — All types of ham rcvrs. in good condition. Highest prices, state price and cond. Conrad Radio, 12908 Lorain Ave., Cleveland 11, Ohio.

SELL OR TRADE — Riders Troubleshooting manuals, vols. 2 to 14, exc. cond., $40 or will trade for 5" scope of standard make in good cond. Howard Trich, 233 Main St., West Senaca, Buffalo 24, N. Y.

FOR SALE — Little used Rider manuals, vols. 1 thru 10, $125. Ralph Stair, 5068 Sherrier Place, NW, Washington, D. C.

FOR SALE — DuMont oscillograph, model 224A, complete w/probe and instruction booklet, $100. Arthur M. Hagendorf, 2039 Gates Ave., Ridgewood 27, L. I., N. Y.

FOR SALE — Battery eliminator, 115 v. AC input, 6 v., 15 amps. output, exc. cond., $17.95 plus COD charges. Ben's TV Service, 680 Clifford Ave., Rochester 21, N. Y.

FOR SALE — 4EL 20 meter beam, self-supporting tower, rotator, indicator; also high and low voltage transformers, meters, chokes, transmitting tubes. R. A. Farmer, Cook Dr., Baldwinsville, N. Y.

WANTED — Mobile 6 v. transmitter for passenger car on 4507.5 and 4585 C.A.P. bands, 12 to 25 w., for cash, 16 mm. sound movie camera or test equip. Mackey's Radio & TV Service, 327 North Spring St., Tupelo, Miss.

TRADE OR SELL — Over 300 tubes mostly older types in orig. cartons, standard brands. Best offer of trade for other types. J. Denaro, 169-10 140th Ave., Springfield Gardens 34, N. Y.

FOR SALE — Like new Hallicrafter SX-71 receiver; Pentron 9T-3C tape recorder; Webster 1127-270HF changer with GE RPX-050 crtg. Prefer local contact. Richard Ebeling, 33 Randolph Rd., White Plains, N. Y.

FOR SALE — Battery operated radios, complete, less batteries: RCA 94BP1, Zenith 4K310, Atwater Kent 82Q. Also Philco AR40 car radio and head, and Zenith with Motorola head, fits '41 thru '48 Chevrolet. Ward Cagwin, Creek Rd., North Tonawanda, N. Y.

FOR SALE — 18 vols. Riders Trouble-shooter guides, exc. cond., $70. H. Gathercole, 45 Aberdeen Dr., Huntington, N. Y.

WANTED — TV set, must be: RCA 630TS or 8TS30; Hallicrafter models T54, 505, 506, or 514. Harry Johnson, Birch Run, Mich.

FOR SALE — Sprague Kwik-Test capacitor checker, model KT-1, excellent condition with operating instructions, $27.50. C. B. Davis, 2215A Lindmont Circle, NE, Atlanta, Ga.

WANTED — Lampkin freq. meter and deviation meter. Trade McElroy FU-40 50W transmitter w/power supply, Argus C-2 35 mm. camera and new case. B. R. Rinn, Yuma, Colo.

WANTED — Hickok tube tester; EMC 700 gen.; model TV-50 Genometer; L-C-R bridge; Eico model 147 sig. tracer. Hugh Brown, 923 Washington Street, Evanston, Ill.

FOR SALE — Superior 1226 Powerstat, $25; Electrovoice 635 mike, $25; Sola 3004 (30808) constant voltage xformer, $45; above all like new; Browning Labs P4 synchroscope, $60. W. C. Woods, 43 Richardson Rd., Lynn, Mass.

SELLING OUT — All ham gear: xformers, scope, 10 meter beam, 600 w. xmitter, etc. Send self-addressed and stamped envelope for list. W. Luce, Box 261, Aquebogue, N. Y.

WANTED — EMC, Eico VTVM and/or sig. gen. What have you? Murray's 610 Stone St., Kings Mountain 1, N. C.

FOR SALE — 10 meter mobile rig, pioneer dynamotor 516 v. at 175 MA, Gonset tri-band converter, Lysco model A-129 10 meter transmitter, $50 postpaid. Jack A. Johnson, Box 56, Delton, Mich.

SELL OR TRADE — Super 6 converter with 96" whip on 132 series mount and 18° shielded lead, 1 yr. old, $60; Winchester model 74 .22 target rifle with K 2.5 Weaver scope, perf., $60. Want 10 coin operated radios in perf. shape. Meryle Hansen, Box 126, Ruthton, Minn.

WANTED — Scope A-1 cond., either Jackson model CRO-2, Hickok 640, RCA WO56A, 78A, or 88A. J. E. Crowder, Willis Wharf, Va.

FOR SALE — EMC model 106 VTVM, used very little, $25. Cecil R. Wallace, Route 4, Albertville, Ala.

SELL OR TRADE — Practical Radio Communication, 2nd Ed., by Nilson and Hornung; and Practical Mathematics for Home Study, 3rd Ed., by Palmer and Bibb. Alexander Podstepny, 1009 North 2nd St., 2nd Floor, Philadelphia 23, Pa.

WANTED — Small 2 meter transmitter about 20 w. for phone and ICW with power supply, clean and neat for cash. L. Weintraub, 1355 Peabody St. NW, Washington, D. C.

SELL OR TRADE — Unused Regency RC-600 and Sutco model 22B UHF converters, $25 each, $40 for both. Write first. Ben W. Mueller, RFD 2, North Tonawanda, N. Y.

FOR SALE — National NC57 comm. rcvr., headphones and signal strength meter, $55. Francis P. Cullen, 93-10 43rd Ave., Elmhurst 73, N. Y.

SELL OR SWAP — 0 to 500 mill meters, 0 to 1 mill meters and others, and Carter dynamotor, 350 v. output, 6 v. input. Want 8 mm. movie camera and 8 mm. movie projector. C. Keeler, 66 Franklin St., Port Jervis, N. Y.

FOR SALE — Delco radio, fits Chevrolet cars 1941 thru 1948. Appearance and performance like new, $25. Edward J. Simek, 1124 4th St., Devils Lake, N. D.

SWAP — BC-348, BC-221, BC-455; 100-156 mc. f5 meter; sig. gen.; W.E. 28C rcvr.; BC-610 plate filter choke for any 20-60 or 140-180 mc. FM equip. Joel B. Jones, 1222 Cruiser Ave., Louisville 5, Ky.

TRADE — Radio-TV tubes: 6SN7, 12AX7, 12AU7, 6BQ6, 5U4, 6BQ7, all l. n., boxed; Heath FM tuner with cabinet and 6 w. amplifier with pre-amp. Want Dynamic tube tester, Precision E200C sig. gen. Herbert Piller, c-o Polytechnic Institute, Brooklyn 2, N. Y.

WANTED — Tape recorder in good operating cond. Will swap B&J 2¼ x 2¼ press camera with photo-flashgun, 6 film holders and film pack adaptor, in perf. cond., cost $125. Leonard Polikoff, 2464 East 21st St., Brooklyn 35, N. Y.

SELL OR SWAP — Supreme model 504A tube and set tester, l. n., checks all tubes up to date, voltage, current, etc., $40 cash or ham gear. Eddie Gigliotti, 249 South Main St., Bangor, Pa.

SELL OR SWAP — RCP 448 VOM, 5,000 ohms volt; Collins CTU 50 kc. freq. std. and harmonics, mod., 110 AC-DC; 35 mm. Clarus f2.8, 1,000th, and case. Need Log Taper 10,000 w.w. pot; 1% Cap.; mod. meter. Lazzeri, 300 North 8th St., Brooklyn 11, N. Y.

FOR SALE — 1949 Buick radio with new guarantee, perf.| cond., $50. Original price $120. Len F. Case, 435 Chapin St., Chadron, Neb.

FOR SALE — Complete Capital TV Eng. Correspondence course, $75, or trade for tape recorder. Also want Geiger counter in operating cond. James A. Dicus, 4725 Ashbury Dr., New Orleans 21, La.

FOR SALE — Hallicrafters rcvr., model S40B, exc. cond., all new tubes, 4 yrs. old, $70. E. R. Giese, Box 126, Palmyra, Wis.

SELL OR TRADE — Heath AR-2 comm. rcvr. in A-1 alignment and cond., Heath cabinet, $24 or what have you. J. W. Eckenwiler, 1664 Betz Dr., Akron 6, Ohio.

WANTED — Schematic and aligning procedure for Philco, model 37-610, Code 126 (not 122) rcvr. John Acree, 5061A Delmar Blvd., St. Louis 8, Mo.

FOR SALE — Eico scope 425; Eico multi-signal tracer; complete ICS radio and electronics course. Armando Marchegiano, 1734 Johnston St., Philadelphia, Pa.

FOR SALE — Standard sig. gen., model 78B, Measurements Corp., $5 express collect. Oscar Johnson, 145 Attridge Rd., Churchville, N. Y.

SELL OR TRADE — Raytheon 5T11 85 w. RF amplifier; original DeForest one-tube rcvr. with hand-made DeForest tube, exc. cond.; Signal Corps I-222-A RF sig. gen., l. n., $125; Rider Chanalyst, all cables, $85. J. A. Hauser, 200 Hudson Ave., Albany, N. Y.

FOR SALE — TDC Bell & Howell tape recorder, in orig. box, with registration card and guarantee, list price $250. Make offer. A. Feinberg, 1127 Sheridan Ave., Bronx 56, N. Y.

FOR SALE — Proceedings of American Institute of Electrical Engineers, 1947 to 1952, also some issues of Power Plant Engineering. Make offer. D. C. Harrington, 2508-B 36th St., Los Alamos, N. M.

FOR SALE — TV 10" table Motorola TS9D, mah. cabinet, exc. cond., $25; RCA 621 table, mah. cabinet, needs 7DP4, $20; Hallicrafters R46 spkr. with output transformer, perf., $14. A. C. Livingstone, 12-01 Ellis Ave., Fair Lawn, N. J.

SWAP — Epiphone "Electar" Hawaiian electric guitar, for tape recorder, or make offer. Frank Leslie, 26 Valleyview Dr., Dayton 5, Ohio.

POSITION WANTED — in or near St. Petersburg, Fla. Radio and TV serviceman, have good references. Paul L. Stephenson, 526 Mill St., Bremen, Ohio.

SWAP — 50 lessons CREI Practical Radio Engineering course, valued at $50, for NC-57 or S-40 rcvr. Warren Jarvis, 139-28 230th Pl., Laurelton, L. I., N. Y.

SELL OR TRADE — Eico 320 $18, 360 $28, both l. n.; Riders 1-5 abridged, 6-20 inc., l. n., $150; Triumph 3" scope, $25, FOB. What have you? W. W. Brock, 2802 Gabriel Ave., Zion, Ill.

SWAP — Like new Setchell-Carlson TV chassis, complete with tubes, or tape recorder for good used sound movie projector, preferably Bell & Howell. Also want 3-speed record changer and tube checker. Russell Jansen, 329½ Prospect Terr., Freeport, Ill.

WANTED — Phone-CW transmitter for 40 and 80. Must be guaranteed, completely TVI free. Any size between 40 and 200 w. considered. Arthur Ideker, 1505 West 14th Ave., Pine Bluff, Ark.

FOR SALE — Amplifier Corp. of America 40 w. audio amp., and model 554 Motorola pushbutton car radio, 1954. Best offers. Edward G. Tanrath, R. 2, Algonquin, Ill.

SELL OR TRADE — Riders 1 to 14 inc., AM-FM manuals, $5 ea.; Approved A-200 sig. gen., $18; Triplett vibrator tester, $18 ,all fine cond. Want mobile rig, ham rcvr., audio osc. John Graham, Box 68, Wurtsboro, N. Y.

WANTED — Triplett sig. gen., sweep gen., and marker. G. R. Calvert, Box 637, Auburndale, Fla.

WANTED — Heathkit type AG audio gen., 20 cy. to 1 mc. range. Jerome Mendel, 938 Kenyon Ave., Plainfield, N. J.

FOR SALE — Riders manuals for radio 1 to 8 and 13 for $30 plus shipping. Len Sporn, c-o N. Schotz, 83 North 5th St., Paterson, N. J.

FOR SALE — Perf. cond. Hi-Fi amplifier Bogen type. Victor Bou, 142 Wyoming Ave., Audubon 6, N. J.

WANTED — Used tape recorder. Charles Wendell, 19 Donald St., Bloomfield, N. J.

SELL OR TRADE — Millen model 90811 high freq. RF final, 90 w. output, complete with 829B tube and 10 meter coils, $25, or what have you? S. Winston, 55 Chumasero Dr., San Francisco, Calif.

WANTED — Instructograph code machine with 3-15 word/min. tape; S-76 Hallicrafters radio, state price and cond. Edward J. Daley, Peterson Rd., Vernon-Rockville, Conn.

FOR SALE — Precision 954 tube tester, has multimeter, condenser checker, battery tester, perf. cond., $82; Sprague Kwik-Test, like new, $26; Philco sig. gen., to 30 mc., $18; Precision E-200C, l. n., $55. A. Salsberg, 438 Saratoga Ave, Brooklyn 33, N. Y.

FOR SALE — Little used crystal mike, Astatic T-3, with desk stand and cable, $10. Fred Fleck, 5853 North Central Ave., Chicago 30, Ill.

FOR SALE — Precision EV10, metal carrying case, $75; Precision tube and set tester 954G in walnut carrying case, $50. Both practically new. Allan Matros, 248 Roxbury Rd. South, Garden City, L. I., N. Y.

WANTED — Push-pull scope, Precision gen., sweep gen. with cables. Have 120 bass, 4 automatic switches, new piano accordion, or trade for 21" TV console with cascode tuner. John Arnold, Box 84, Bluffs, Ill.

SELL OR TRADE — Ham parts, power supplies, receiver for converter, VFO or what you have. Bill Grebe, 518 West Ninth, Loveland, Colo.

FOR SALE — Hallicrafters SX-42 with R-46 speaker and Harvey Wells Bandmaster deluxe, $275. Both like new. Nils A. Hallstrom, Box 146, North Bend, Wash.

SELL OR TRADE — Hallicrafter S-77, 9 tubes, 4 bands, AC-DC, $50. Want shortwave converter to AC radio. R. Garcia, 300 West 17th St., New York 11, N. Y.

POSITION WANTED — Young helper, age 15, taking NRI course on radio and TV wants to serve apprenticeship. Will work as stock boy, or helper. Don Cannady, R. 3, Box 639, Terre Haute, Ind.

SELL OR SWAP — Heathkit AR-1, used, complete; Superior TV-11, unused tube tester; Superior 670-A, unused Super-Meter. Want tape recorder in very good condition. Solomon Kessler, 85 Lancaster St., Portland 3, Me.

SELL OR TRADE — Tubes: 12B8GT, 32L7GT, 7193; 1940 Chrysler auto radio; woodworking tools. Want xmitters, receivers 145-147 mc., 220 mc. and up. Local Philadelphia, Pa. W. I. Barry, 1229 Edgehill Rd., Darby, Pa.

WANTED — 3" Pilot TV, state price and cond. Bob White, Box 547, El Cerrito 6, Calif.

FOR SALE — 10" E-D speaker with 12" cable, plug and output transformer; two hash filter assemblies. Both for $5.50. T. A. McDonald, 2682 Tremainsville Rd., Toledo 13, Ohio.

POSITION WANTED in radio servicing. Have National Schools training, salary secondary. Owen Williams, Vermilion, Alberta, Canada.

FOR SALE — Two G.E. power transformers, 1½ KVA, low voltage - 120/240, high voltage - 2160-2200-2400. Excellent for high voltage ham rig power supply, plenty of mills, $25 each FOB. E. C. Sanders, 209 North Wichita, Electra, Tex.

WANTED — 0-1 DC milliampere with 50 ohm internal resistance movement meter, state price in first letter. Derry's Radio Shop, King's Mountain, Ky.

WANTED — Precision Series 10-54 or 10-12 tube tester; also E-400 sweep sig. gen. Will pay cash, state cond. L. Greenblatt, 144-40 77th Rd., Flushing 67, N. Y.

SELL OR SWAP — Heathkit visual-aural sig. tracer, model T-3 in perf. cond. Need one of the following VTVM or VOM: Sylvania Polymeter, Triplett 630 VOM, Precision 120 or ?? Sal Isgro, 118 Gamewell St., Hackensack, N. J.

FOR SALE — NRI radio course in AM-FM-TV, has 65 lessons and large glossary book, as is, $20. Agostino, 223 South Winebiddle Ave., Pittsburgh 24, Pa.

FOR SALE — Fisher 70-RT AM-FM tuner; Fisher 70-AZ 25 w. Hi-Fi amplifier. Latest models used few times, $200 for both. Dr. Alan York, 35 Main St., East Hampton, L. I., N. Y.

FOR SALE — Modern Radio Servicing and Radio Physics course, both by Ghirardi, $3.75 ea., l. n. cond. Radio-TV Service, 1316 42nd St., Brooklyn 19, N. Y.

WANTED — Rider or RCA Chanalyst, State cond. and price. Goldinger, Box 172, Woodbine, N. J.

SELL OR SWAP — BC-459A, 6HP outboard. Want signal tracer kit and Micro record dev. equip. Harold Denny, Portersville Rd., Washington, Ind.

SELL OR TRADE — SX-42, R-42 speaker, good cond., factory reconditioned, $150; Carter Genamotor, 350 v., 200 MA, $25; Jewel 7" Galanometer; ham gear. Need Viking II, 3" Heath scope. Floyd Bitters, R. 2, Peoria 5, Ill.

SWAP OR SELL — Webster model 100 record player, slightly used, no amp., $15; Eico model 221 VTVM, perf., $17 or swap for Sprague Tel-Ohmike and cash. Also 17FP4A RCA CR tube, unused, $10 cash. A. Tiefenbruner, 2734 Sedgewick Ave., Bronx 68, N. Y.

FOR SALE — Millen 90800 transmitter, coils for 10-20-75 meters, TVI'd, $30; Sams Photofacts, vols. 1 thru 10 with binders, l. n., $100. William Gilley, 951 Mark Ave., Hamilton, Ohio.

FOR SALE — Mounted Balun coils $7; Astatic 54M3 mike $4; Amphenol 20 meter folded dipole $4. A. Bogart, Emporium, Pa.

SELL OR SWAP — Midwest radio chassis, complete with speaker, 5 bands, incl. FM, only three months old. Want tape recorder or 16 mm. projector. F. L. Sommer, Box 307, Dover, N. J.

FOR SALE — New RCA color TV course; 7" and 16" TV chassis. H. Bell, 3917 Ely Ave., Bronx 66, N. Y.

SELL OR TRADE — Keystone projector; DC volt and milliamperes; radio parts and books. Reasonable, send for list. Vincent P. Kuszewski, 43 Illinois St., Worcester 10, Mass.

FOR SALE — TV shop: test equip, Precision tube tester, 10-54P, EV10, E-200 plus RCA 3" scope, Simpson, Eico meters, TV and radio sets, tools, etc., $800. Rent $25 mo., individual pieces sold. Evenings 7-10, all day Saturday. P. T. Pickel, 1774 Merrill St., Bronx, N. Y.

WILL SWAP — Zenith portable radio, lists $55.95, less batteries; disc recorder, cutting head and playback; two-way intercom, for 4x5 camera or flash unit or 3" scope. Emory Corron, 4096 Redonda Lane, Dayton 6, Ohio.

FOR SALE — Radio City model 710 pocket sig. gen., 456, 465, 550 and 1500 kc., good cond., $5. Edwin C. Eisenbeis, 2813 Sheila Dr., Louisville 5, Ky.

SELL OR TRADE — Like new Jensen C-81 base reflex enclosure and Permoflux 8UP81 extended range Hi-Fi speaker to highest reasonable offer. H. Gehring, 1200 Stockwell, El Paso, Tex.

FOR SALE — Sylvania tube tester, model 220, 6 mos. old, l. n., $85. Steve LeVay, 175 State St., Perth Amboy, N. J.

FOR SALE — GE cliplock meter, 600 v. 600 amp., $60; Superior instrument utility tester, $15; Supreme tube tester 589A, $15; Tele-Talk-Master station and spkr., 105M, $10; photo cell and counter, $35. George Mickle, 7935 Dorchester Ave., Chicago 19, Ill.

FOR SALE — 78 Emerson disc recorder, perf. working order, input for mike, amp. neon vol. indicator, amp. mike, on-off, vol. switches, instructions incl. Best offer over $30. Robert D. Arigoni, 42 Spring St., North Adams, Mass.

WANTED — Auto radio for '52 Ford. For sale a 12" Airline TV console, cheap or swap for test equip. Verne Wilson, Mackinaw City, Mich.

SELL OR TRADE — 1 to 5 amp. ohmite rheostats, 18 ohm 5" diameter and 60 ohm 8" diameter. Best offer or trade for 6146's, 829 or six meter beam. R. E. Neal, 249 Old Abingdon Hwy, Bristol, Va.

SELL OR TRADE — 5" D.T.I. scope, good cond., with full instructions; Heath SG-8 sig. gen., l. n., calibrated with Precision E-200. Will trade for most anything, need Isolation transformer. Sam Brence, Box 91, Crescent, Okla.

WANTED — Microphones: used Western Electric model 639 Bird Cage; used RCA model 77. Ken Dambach, 150 Garfield Pl., Maplewood, N. J.

WANTED — Zenith AM FM radios; Resistor cabinets with or without resistors; Sams folders above 185. G. H. Swiska, 109 East School St., Woonsocket, R. I.

WANTED — Comm. rcvr., Heath, etc. Have Eico 320 sig. gen. with 3 trimmers and new band switch, and code practice jack. Have .039 "CUB" engine, l. n., and 1932 auto radio. John M. Hicks, 1136 Margray St., Pittsburgh 7, Pa.

SELL OR SWAP — Philco 15 tube rig, logged Australia, Denmark, Belgium, Bulgaria, Turkey, etc. Want NC-88 or other compact wide-range rcvr. Jason Birnholz, 634 High St., Newark 2, N. J.

WANTED — Technical info and supply source of small 6 v. vibrator supplies Radiart type CRF 20221-A using wet cell battery type NT-6. State quantity, price and condition. Peter Kacoure, 148-09 Jamaica Ave., Jamaica 35, N. Y.

FOR SALE — RCA Reg. power supply, MI-26085-A for TV camera, 260-300 v. DC, 600 MA, $50; four RCA filament transformers, Pri 220, 205, 190 v., secondary 5 v. at 10 amps, 22000 v. sec. insulation, $10 ea. FOB. W. Sugarman, 3228 West Oxford St., Philadelphia, Pa.

FOR SALE — Like new RCA WO-56A scope, $175.; l. n. RCA WV-75A VTVM, $70; Weston 772 analyzer, 773 tube tester and 779 VOM, $50 each; Weston 776 osc., $25; Triplett 666R VOM, $10. H. A. Vosburgh, 503 Melrose Ave., Ambridge, Pa.

FOR SALE — Sylvania model 501 marker generator; Heathkit model 0-8 scope; Heathkit V.C.1 scope voltage calibrator, RMS bar generator. Robert Fellows, 90 North St., Caledonia, N. Y.

WANTED — Original or replacement pwr. transformer for Philco model 48-700, Philco part No. 32-8364-1. Will take whole chassis if cheap enough, give details in first letter. James H. Horton, 2908 Venice Rd., Sandusky, Ohio.

SWAP — Printing press, 2½ x 3¾, type, stock; 5 x 7 camera; for Heathkit sig. tracer or National SW-3 battery rcvr. Robert H. Cushing, 12 Carver Street, Plymouth, Mass.

SELL OR SWAP — Eico model 145 signal tracer and Eico model 320 sig. gen., $25 each, or swap for model 155 Hickok tracer. Arnolds Radio Service, Box 37, Copenhagen, N. Y.

FOR SALE — Van Dorn breast drill, ½" chuck, 110 v. AC, 4.5 amps, good cond., $15. Marvin Shapiro, 1240 Sherman Ave., Bronx 56, N. Y.

FOR SALE — Unused electric eye dimmer control for GM cars. Want rec. for 152-173 mc. W. E. Fuller, 3137 West Michigan Rd., R. 1, Dimondale, Mich.

TRADE — Never used 813 xmitting tube, for good used Heathkit VTVM, model V-4A or later. Harry Niccum, 6514 Aldama St., Los Angeles 42, Calif.

FOR SALE — Hi-Fi equip. Write for list. Gary Gottlieb, The Cambridge School, Weston 93, Mass.

WANTED — Surplus tubes, diode crystals and other electronic gear. Will pay cash and shipping charges. Send list. B. N. Gensler, 330 West 11th St., New York 14, N. Y.

TRADE OR SELL — Used transtat variac 23 KW 0-115 v. at 20 amp max and Heath FM receiver for used Rekokut or similar turntable. Kai Klemm, 307 West 79th, New York 24, N. Y.

FOR SALE — Astatic FLC pick-up, 78 rpm Diamond cartridge and FLC filter, Shure 710 crystal mike, output trans., G.E. record compensator A1900, tubes. J. Holloway, YMCA, Rm-643X, Philadelphia 2, Pa.

SELL OR SWAP — 75 meter 10 w. transceiver (phone) 6L6 final and 6L6 modulator tubes, ruggedized. $35 or what have you? Thayer, 100 Calvert Ave., Clinton, S. C.

FOR SALE — Slightly used Admiral radio phonograph combination, 3 speeds, tone control, model 5D32, 5 records included, $40, city sale preferred. Clifford Patterson, 104 - 23 123rd St., Richmond Hill, N. Y.

SELL OR TRADE — Radio rcvrs., radio and phono combs., equip., and publications dating from 1919 thru 1927. Will sell or trade for Cord car. Howard C. Bergstrom, 1717 South 29th St., Omaha 5, Neb.

SWAP OR SELL — General Industries disc recorder; 12½" Dumont Chattam; PA system with 18 w. amplifier, 2 12" speakers and carrying case. Jack Stollman, 919 Saratoga Ave., Brooklyn 12, N. Y.

SELL OR SWAP — Transmitting tubes, power xformers, meter, crystals, dynamotors, diathermia, relays, chokes, Hallicrafter SX-10. A. Zambakian, 1259 Gaylord St., Denver 6, Colo.

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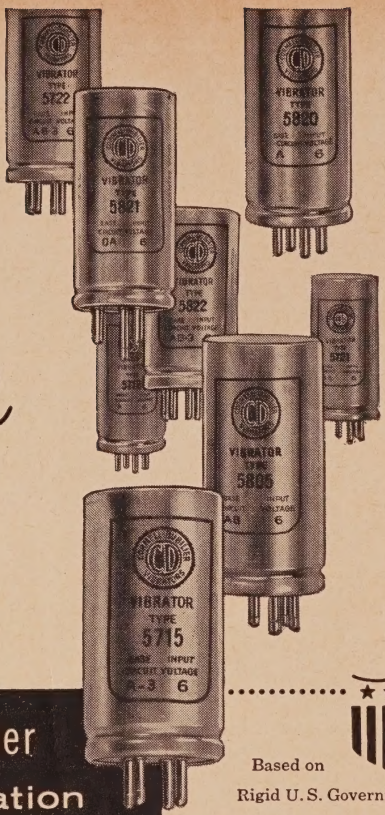

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